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(57) Claim

1. A beam comprising two vertical webs which are parallel to each other and are spaced apart horizontally and further comprising a plurality of intermediate elements which extend between the webs, wherein each intermediate element has a length less than the length of the webs and the intermediate elements are spaced apart along the beam.

9. A method of making a beam comprising the steps of making two elongated elements by extruding metal, making a plurality of relatively short elements by extruding metal and severing the extrusion transversely of its length and the step of attaching each short element between the elongated elements so that the elongated elements are connected togetner by the short elements and the short elements are spaced apart along the elongated elements.

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COMPLETE SPECIFICATION

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Complete Specification for the invention entitled:

BEAM AND METHOD OF PRODUCING BEAM

The following statement is a full description of this invention, including the best method of performing it known to us

PATENTS ACT 1977
SHL/PL/80.047

Title: "Beam and method of producing beam"

Description of Invention

This invention relates to a beam of the kind comprising at least a pair of vertical webs which lie in face-to-face relation and are spaced apart horizontally and further comprising at least one intermediate element which extends between the webs and contributes to the resistance of the beam to buckling of the webs.

In the design of a beam for a particular duty, a compromise must be reached between the requirement that the beam should have sufficient strength and stiffness to avoid permanent deformation and excessive elastic deformation and the requirement to reduce the amount of material required for the manufacture of the beam.

In U.S. patent 3,789,563, it has been proposed to form a beam having a pair of vertical, sheet metal side walls, lower marginal portions of which are connected together by a lower extrusion and upper marginal portions of which are connected together by an upper extrusion. The side walls and the extrusions together form a box section. In U.S. patent 4,177,968, there is disclosed a soldier for use in concrete formwork, the soldier comprising a pair of channel members arranged back-to-back and spaced apart and connected together by three connecting members disposed between and welded to respective bases of the channels. The channels are further connected together at their ends by end caps. Each connecting member is of tubular form and is arranged with

its length extending transversely of the length of the soldier. The connecting members are spaced widely from each other and from the end caps. The function of the connecting members is to maintain the required spacing between the channel members.

According to a first aspect of the present invention, there is provided a beam comprising two vertical webs which are parallel to each other and are spaced apart horizontally and further comprising a plurality of intermediate elements which extend between the webs, wherein each intermediate element has a length less than the length of the webs and the intermediate elements are spaced apart along the beam.

The expression "length" is used herein to designate a dimension extending along the beam, the expression "depth" is used to designate a vertical dimension and the expression "width" is used to designate a horizontal dimension which is transverse to the length of the beam.

In a beam in accordance with the present invention, the intermediate elements contribute to the resistance of the beam to deformation of the webs and the amount of material required to produce the intermediate elements is less than that required to produce the upper and lower extruded members of the beam disclosed in U.S. patent 3,789,563.

In normal use of the beam, the beam is supported at support positions spaced apart along the beam and is subjected at one or more positions between the support positions to a downward load acting in a direction substantially parallel to the larger dimension of the webs as viewed in vertical cross-section.

The beam preferably comprises a plurality of flanges, each flange projecting from a respective one of the webs in a direction transverse to the faces of the webs.

According to a second aspect of the invention, there is provided a beam comprising two flat webs in mutually spaced, face-to-face, parallel relation, a plurality of flanges, each flange projecting from a respective one of the webs in a direction transverse to the faces of the webs and a plurality of intermediate elements which are spaced apart along the beam and each of which intermediate elements extends between the webs.

According to a third aspect of the invention, there is provided an elongate structure suitable for use as a beam and comprising a pair of members, each of which members extends along the length of the structure, and a plurality of intermediate elements which are spaced apart longitudinally of the structure, wherein said members are formed of metal, have respective webs which lie in spaced apart parallel relation with each other and have respective flanges, each projecting from a respective web in a direction away from the other web, and wherein each intermediate element is formed of metal, has a length less than the length of the structure, is hollow, has open ends spaced apart longitudinally of the structure, extends between the webs of said members and is engaged with each of said members at a plurality of positions which are spaced apart in a direction transverse to the length of the structure.

In a structure according to the third aspect of the invention, there can be used for said pair of members and for the intermediate elements extruded metal sections which are severed to the required lengths. From a single extruded section, there can be severed intermediate

elements of different lengths so that the dimension of each intermediate element which extends longitudinally of the structure can be selected according to the duty for which the structure is intended.

The thickness of the webs is preferably less than the thickness of the flanges. Since the intermediate elements contributes to the resistance of the structure to buckling of the webs, relatively thin webs can be used.

The depth of each web preferably exceeds the lateral projection of each flange from its web.

Each intermediate element is preferably adapted to limit mutual approach of the webs at a selected position.

Each intermediate element is preferably connected with the webs in a manner such that the intermediate element limits the separation of the webs at the selected positions.

Each intermediate element may include wall portions which are parallel to the webs. Each such wall portion may be in contact with a respective web or sufficiently close thereto to inhibit significant buckling of the webs towards each other.

Each intermediate element is preferably restrained against vertical movement relative to each of the webs.

Each intermediate element may be engaged between a pair of opposed upwardly and downwardly facing abutments on each of the webs.

There is preferably engagement between each intermediate element and each web over a distance along the

beam which exceeds the lateral projection of each flange from its respective web.

There is preferably engagement between each intermediate element and each web over a vertical distance which exceeds the lateral projection of each flange from its respective web.

There is also preferably engagement between each intermediate element and each web over a vertical distance which exceeds one quarter of the depth of the webs.

In the preferred construction, there are no apertures through the webs and each intermediate element lies entirely between the webs.

Each intermediate element preferably defines a space lying between respective parts of the element which lie in contact with or adjacent to the webs. The cross-section of each intermediate element, as viewed in a direction along the beam, is preferably a closed figure.

The webs and flanges and/or the intermediate elements may be formed of aluminium and may be extrusions.

According to a fourth aspect of the invention, there is provided a method of making a beam comprising the steps of making two elongated elements, making a plurality of relatively short elements and attaching each short element between the elongated elements so that the elongated elements are connected together by the short elements and the short elements are spaced apart along the elongated elements.

The elongated elements and the short elements may be provided with respective cooperating formations which extend along the lengths of the elements and are mutually engageable with sliding clearance, the elements of each beam being assembled together by engaging the formations of each short element with the cooperating formations of the elongated elements at corresponding ends thereof and sliding the short element along the elongate elements to the required position.

After sliding each short element to the required position, it may be restrained against further sliding along the elongated elements by mechanical deformation of the elongated elements. Alternatively, further sliding may be restrained by welding the elements together or by application of additional components to the elements.

A number of beams in accordance with the first three aspects of the invention and made by a method in accordance with the fourth aspect will now be described with reference to the accompanying drawings wherein each of Figures 1 to 5 shows an end elevation of a respective beam.

The beam illustrated in Figure 1 comprises two main elements, 10 and 11, each of which extends along the full length of the beam.

The main element 10 comprises a vertical web 12 having along its upper margin a laterally outwardly projecting flange 13 and a laterally inwardly projecting flange 14 which projects towards the element 11. Along the lower margin of the main element 10 there is a laterally outwardly projecting flange 15 and a laterally inwardly projecting flange 16. The element is preferably symmetrical about a plane 17 lying halfway between the flanges 13 and 15. All of the flanges of the main

element 10 preferably have the same thickness which exceeds the thickness of the web 12. Typically, the thickness of the flanges is within the range 150% to 250% of the thickness of the web. In the particular example illustrated, the web has a thickness of 4 mm. and the flanges have a thickness of 7 mm.

The main element 11 is identical with the main element 10 and is arranged with its web 18 parallel to the web 12 but spaced horizontally therefrom and the element 11 is reversed, left to right, as compared with the element 10 so that the upper and lower laterally outwardly projecting flanges 19 and 20 of the element 11 project away from the element 10 and the upper and lower inwardly projecting flanges 21 and 22 project towards the flanges 14 and 16 respectively. The webs 12 and 18 are both flat and are arranged in face-to-face relation with the lower surfaces of the flanges 15, 16, 20 and 22 lying in a common horizontal plane.

The horizontal spacing between the webs 12 and 18 is less than the depth of the webs and preferably less than one half the depth of the webs. The width of the inner flanges 14, 16, 21 and 22 is less than the width of the outer flanges 13, 15, 19 and 20 and there is a substantial gap between the lower inner flanges and between the upper inner flanges.

On the face of the web 12 which is presented towards the web 18, there is provided a pair of abutments in the form of respective ribs 23 and 24, each of which extends along the full length of the beam. As viewed along the beam, each rib has an L-shaped cross-section with a first limb 25 projecting horizontally from the web 12 and a second limb 26 projecting towards the other rib.

The beam further comprises a number of intermediate elements which are disposed between the webs 12 and 18 and one of which intermediate elements is indicated in Figure 1 by the reference numeral 27. Each of the intermediate elements has a length which is short, as compared with the length of the beam and the intermediate elements are spaced apart along the beam Typically, the length of the intermediate elements is within the range 50 mm. to 100 mm. The spacing between adjacent intermediate elements may exceed the length of the intermediate elements and the spacing between adjacent intermediate elements may vary along the beam. The intermediate elements are preferably identical with one another.

As viewed in Figure 1, the intermediate element 27 defines a closed figure which approximates to a square. The element includes opposite side walls 28 and 29 which lie adjacent to the webs 12 and 18 respectively. The element further comprises upper and lower walls 30 and 31. The thickness of these walls is somewhat less than the thickness of the webs 12 and 18.

A formation 32 projects upwardly from the junction of the walls 28 and 30 into the downwardly facing channel defined between the rib 23 and the web 12. The formation 32 is somewhat thicker than the side wall 28 and engages the web 12. The formation 32 is a sliding fit in the associated channel. Corresponding formations 33 to 35 on the intermediate member engage in the channels defined by the rib 24 and the ribs 36 and 37 on the web 18. By the provision of the formations 32 to 35, the intermediate element is adapted to prevent movement of the webs 12 and 18 towards and away from each other at the positions where the webs are engaged by the formations.

The main elements 10 and 11 and the intermediate elements 27 are formed of aluminium by extrusion, the extruded material from which the main elements are formed being cut into lengths equal to the required length of the beams and the extruded material of which the intermediate elements are formed being cut into appropriate shorter lengths. The main elements are then placed in the relative position illustrated in Figure 1 and each intermediate element is engaged by its formations 32 to 35 with the main elements at corresponding ends thereof and is slid along the main elements to the required position. To restrain further sliding of each intermediate element along the beam, the ribs 23, 24, 36 and 37 may be deformed locally adjacent to the ends of the intermediate elements. Alternatively, the intermediate elements could be welded to the ribs or to the webs of the main elements. In a further alternative method, separate components may be applied to the ribs or to the webs to restrain sliding of the intermediate elements.

The clearance space between the side wall 28 and the web 12 and the corresponding clearance space between the side walls 29 and the web 18 avoid friction between the side walls and the webs during sliding of the intermediate element to the required position. However, these clearance spaces are sufficiently small for the side walls 28 and 29 to inhibit significant buckling towards each other of the adjacent parts of the webs. Vertical movement of the webs relative to the intermediate element is prevented by engagement of the formations 32 to 35 with the horizontal limbs 25 of the ribs on the main elements. The intermediate element is hollow, there being a clear space between the side walls 28 and 29. If further stiffening is required, one or more horizontal webs extending between the side walls 28 and 29 may be provided. These additional webs may be horizontal or inclined at an acute angle to the plane 17.

The thickness of the side walls 28 and 29 and of the upper and lower walls 30 and 31 of the intermediate element is within the range 50% to 200% of the thickness of the webs 12 and 18 and is preferably within the range 75% to 125% of the thickness of the webs.

In use, the beam is commonly supported at positions adjacent to its ends by means engaging the lower flanges 15, 16, 20 and 22 and is subjected to a downward load distributed along its length or to a number of loads at respective positions between the ends of the beam. The intermediate elements 27 contribute to resistance of the beam to buckling of the webs 12 and 18 and also contribute to resistance of the beam to bending in a horizontal plane.

The ribs 23 and 24 on the web 18 also contribute to resistance of this web to buckling and makes it possible to space the intermediate elements 27 somewhat further apart than would be the case if the ribs 23 and 24 did not extend along the entire length of the web. The spacing between adjacent intermediate elements in the assembled beam may be up to 1.2 metre. This spacing will be selected in accordance with the intended duty of the beam and in accordance with the thickness of the webs, the depth of the webs and the stiffening effect of the ribs.

The beam illustrated in Figure 2 comprises parts which correspond to those of the beam illustrated in Figure 1. In Figure 2 such corresponding parts are indicated by like reference numerals with the prefix 1 and the preceding description is deemed to apply, except for the differences hereinafter mentioned.

The intermediate elements 127 of the beam shown in Figure 2 are arranged in pairs, the elements of each pair being disposed one above the other. The intermediate

elements 127 may be identical with the intermediate elements 27 illustrated in Figure 1 but preferably differ therefrom in that the depth of their side walls 128 and 129 is substantially less than the width of their upper and lower walls 130 and 131.

Formations 132 and 134 of the upper intermediate element 127a engage in downwardly facing channels provided in the upper inwardly projecting flanges 114 and 121 of the main elements 110 and 111. Downwardly projecting formations 133 and 135 of the upper intermediate element engage in upwardly facing channels defined by ribs 123 and 136 on the main elements. The intermediate element is a sliding fit in the channels of the main elements and the lower intermediate element 127b is arranged in a corresponding manner adjacent to the lower margins of the webs 112 and 118. It will be noted that there is a vertical gap between the intermediate elements shown in Figure 2. The beam illustrated in Figure 2 is manufactured in a similar manner to that in which the beam of Figure 1 is manufactured.

The beam illustrated in Figure 3 includes parts which correspond to parts of the beam hereinbefore described with reference to Figure 1. Such corresponding parts are indicated in Figure 3 by like reference numerals with the prefix 2 and the preceding description is to be deemed to apply, except for the differences hereinafter mentioned.

Each intermediate element 227 of the beam shown in Figure 3 extends from the upper margins to the lower margins of the webs 212 and 218. Upwardly projecting formations 232 and 234 on the intermediate element engage in downwardly facing channels formed in the inwardly projecting upper flanges 214 and 221. Downwardly projecting formations 233 and 235 engage in upwardly

facing channels formed in the lower inwardly projecting flanges 216 and 222. In other respects, the beam shown in Figure 3 is similar to that shown in Figure 1.

The formations 232 to 235 of the beam shown in Figure 3 have a profile, as viewed along the beam, which is rectangular. This may be modified to a dove-tail profile, the cross-sectional shape of the channels in the main elements 210 and 221 being modified in a corresponding manner so that the intermediate element cooperates with the inwardly directed flanges to prevent movement of these away from each other upwardly and downwardly.

In a further modification, the clearance spaces between side walls of the intermediate element 227 and the webs 212 and 218 may be eliminated.

In an alternative modification of the beam shown in Figure 3, the channels defined by the main elements 210 and 211 adjacent to upper margins of the webs 212 and 218 may be downwardly divergent and the channels adjacent to lower margins of the webs upwardly divergent. The formations on the intermediate element which engage in these channels are tapered in a corresponding manner. These formations may comprise parts of the side walls, upper and lower walls rather than projections extending from these walls. With this arrangement, the upper and lower walls would be flat only in a region between the flanges of the main elements.

Certain parts of the beam illustrated in Figure 4 correspond to parts of the beam hereinbefore described with reference to Figure 1. Such corresponding parts are indicated in Figure 4 by like reference numerals with the prefix 3 and the preceding description is deemed to apply except for the differences hereinafter mentioned.

Each of the webs 312 and 318 of the beam shown in Figure 4 has only a single rib, 323 and 336 respectively. The intermediate element 327 is engaged between these ribs and the lower inwardly projecting flanges 316 and 322.

The side wall 328 and adjacent parts of the upper and lower walls 330 and 331 present a dove-tail profile, as viewed along the beam, and are received in a complementary recess defined by the rib 32_, the web 312 and the flange 316. The intermediate element cooperates with the main element 311 in a corresponding manner. There extends between the side walls 328 and 329 across the hollow interior of the intermediate element a single horizontal web 338.

There depend from the lower wall 331 between the main elements 310 and 311 formations 339 and 340 which have the profile, as viewed along the beam, of a hook. These formations facilitate the suspension from the beam of additional members, for example further beams which extend transversely of the beams from which they are suspended. When a member is suspended from these formations, a downward load is transmitted from these formations to the lower inwardly directed flanges. The beam may be supported by means engaged with the upper flanges, either the laterally outwardly directed flanges and/or the inwardly directed flanges.

The side walls 328 and 329 of the intermediate element of the beam shown in Figure 4 engage the webs 312 and 318 over the entire depth of the side walls. In a modification of the beam illustrated in Figure 4, a clearance space is provided between each side wall and the adjacent web. It will be noted that a part of the upper wall 330 lying between the ribs 323 and 336 engages both of these ribs and thereby limits mutual approach of the webs in the region of these ribs.

Certain parts of the beam illustrated in Figure 5 correspond to parts of the beam hereinbefore described with reference to Figure 1. Such corresponding parts are indicated in Figure 5 by like reference numerals with the prefix 4 and the preceding description is deemed to apply, except for the differences hereinafter mentioned.

The beam illustrated in Figure 5 has upper intermediate elements 427a and lower intermediate elements 427b. Each of these elements has a depth approximately one third the depth of the beam and the elements are spaced apart vertically.

The upper intermediate element 427a has upwardly projecting formations 432 and 434 with a dove-tail cross-section which are received in complementary channels formed in the upper laterally inwardly directed flanges 414 and 421. Upper ribs 423 and 436 on the webs 412 and 418 respectively also have a dove-tail cross-section and are received in complementary channels formed in the side walls 428 and 429 of the intermediate element 427a. The intermediate element is thereby adapted to restrain deflection of the webs away from each other in the vicinity of the ribs 423 and 436 and also in the vicinity of the upper flanges. The side walls of the intermediate element 427a are in contact throughout their height with the webs 412 and 418 to restrain mutual approach of the webs.

The arrangement of the lower intermediate element 427b corresponds to that of the upper intermediate element 427a.

In a modification of the beam shown in Figure 5, each pair of vertically spaced intermediate elements 427a and 427b is combined into a single intermediate element which cooperates with a single rib on each of the webs

412 and 418. Upwardly and downwardly projecting formations on the single intermediate element cooperate with the inwardly directed flanges in the manner illustrated in Figure 5. The single intermediate element has a horizontal web connecting its side walls at the level of the ribs on the webs 412 and 418.

All of the beams herein described may be produced in a manner corresponding to that hereinbefore described with reference to the beam illustrated in Figure 1. After assembly of a beam and during transport of the beam to the place of use, some or all of the intermediate elements of a beam may be slidable along the beam so that they can be adjusted along the beam on site according to the conditions of use of the beam. For example, if an unobstructed gap is required between the main elements of the beam at a particular position along the beam, the intermediate elements can be moved away from that position.

One or more intermediate elements of a beam may be arranged partially to project beyond the adjacent free ends of the associated main elements of the beam. Such projecting portions of the intermediate elements enable beams to be connected end-to-end, the projecting portions of the intermediate elements being received between the main elements of an adjacent beam. A connection between adjacent beams arranged end-to-end may be made by engaging a projecting portion of an intermediate element of one of the beams between the main elements of the other beam and engaging a projecting portion of an intermediate element of the other beam between the main elements of the one beam, one of these intermediate elements lying above the other intermediate element.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:
~~CLAIMS:~~

1. A beam comprising two vertical webs which are parallel to each other and are spaced apart horizontally and further comprising a plurality of intermediate elements which extend between the webs, wherein each intermediate element has a length less than the length of the webs and the intermediate elements are spaced apart along the beam.

2. A beam comprising two flat webs in mutually spaced, face-to-face, parallel relation, a plurality of flanges,each flange projecting from a respective one of the webs in a direction transverse to the faces of the webs and a plurality of intermediate elements which are spaced apart along the beam and each of which intermediate elements extends between the webs.

3. An elongate structure suitable for use as a beam and comprising a pair of members, each of which members extends along the length of the structure, and a plurality of intermediate elements which are spaced apart longitudinally of the structure, wherein said members are formed of metal, have respective webs which lie in spaced apart parallel relation with each other and have respective flanges, each projecting from a respective web in a direction away from the other web, and wherein each intermediate element is formed of metal, has a length less than the length of the structure, is hollow, has open ends spaced apart longitudinally of the structure, extends between the webs of said members and is engaged with each of said members at a plurality of positions which are spaced apart in a direction transverse to the length of the structure.

4. A beam according to claim 2 or a structure according to claim 3 wherein the thickness of the flanges exceeds the thickness of the webs.

5. A structure according to claim 3 wherein each intermediate element is engaged with each of said members without interruption over the entire distance between said positions which are spaced apart in a direction transverse to the length of the structure.

6. A beam according to anyone of claims 1,2 and 4 or a structure according to anyone of claims 3,4 and 5 wherein each intermediate element is engaged between a pair of opposed upwardly and downwardly facing abutments on each of the webs.

7. A structure according to claim 6 wherein said spaced positions at which each intermediate element is engaged with each of said members are spaced apart by a distance which exceeds the lateral projection of each flange from its respective web.

8. A beam according to anyone of claims 1,2 and 4 or a structure according to anyone of claims 3 to 7 wherein there is engagement between each intermediate element and both of the webs over a distance extending along the webs which is greater than the lateral projection of each flange from the webs.

9. A method of making a beam comprising the steps of making two elongated elements by extruding metal, making a plurality of relatively short elements by extruding metal and severing the extrusion transversely of its length and the step of attaching each short element between the elongated elements so that the elongated elements are connected together by the short elements and the short elements are spaced apart along the elongated elements.

10. A method according to claim 9 wherein the elements of each beam are assembled together by engaging

formations of each short element with co-operating formations of the elongated elements at corresponding ends of the elongated elements, sliding the short element along the elongate elements to the required position and restraining the short element against further sliding.

11. A method of producing a beam substantially as herein described with reference to and as illustrated in the accompanying drawings.

12. A beam substantially as herein described with reference to and as illustrated in anyone of figures 1,2,3,4 and 5 of the accompanying drawings.

13. Any novel feature or novel combination of features disclosed herein or in the accompanying drawings.

DATED this 2nd day of November 1981.

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I certify that this and the preceding 18 pages are a true and ex act copy of pages ---------- of the specification originally lodged.

J A Bowen

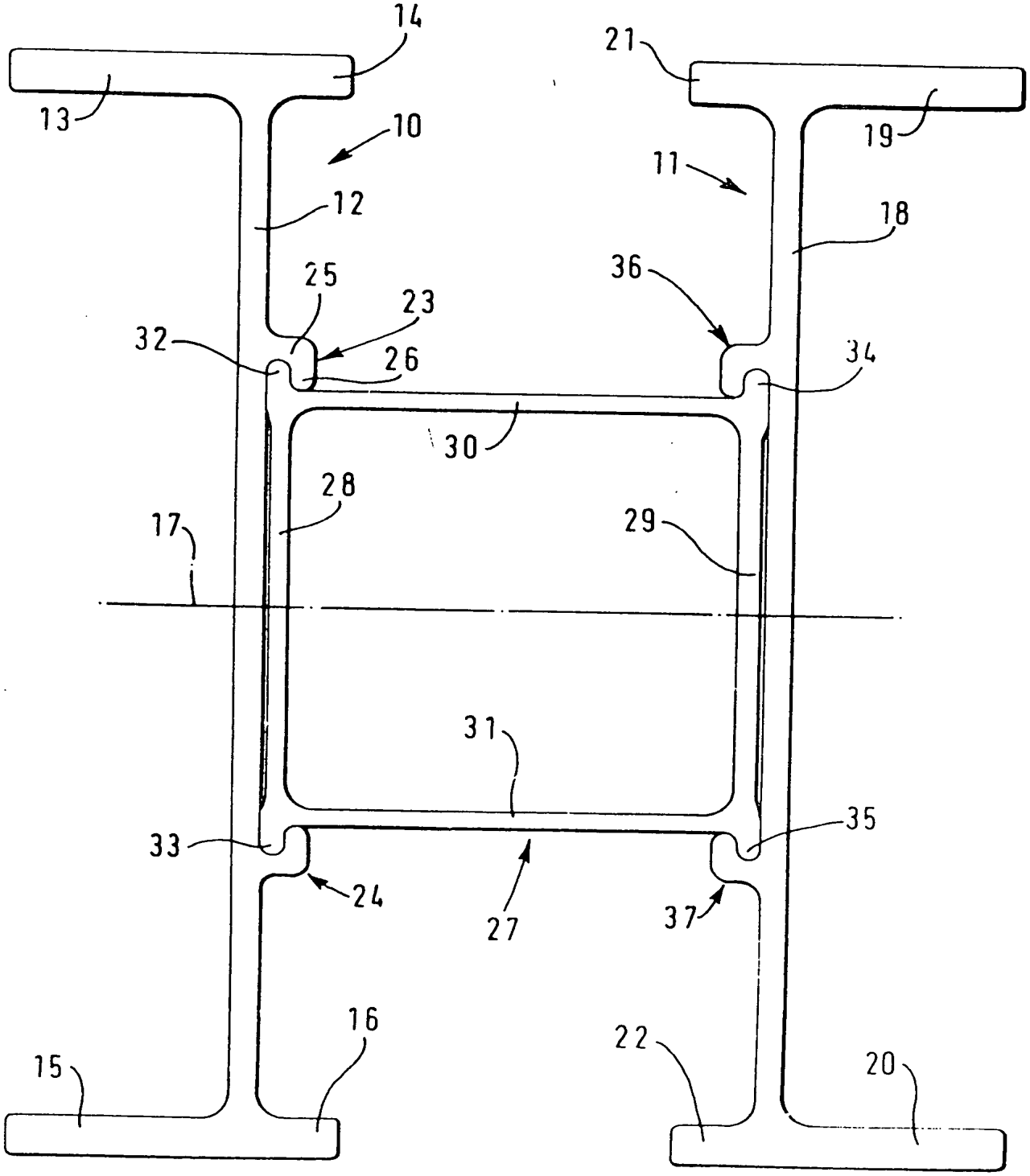
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FIG 1

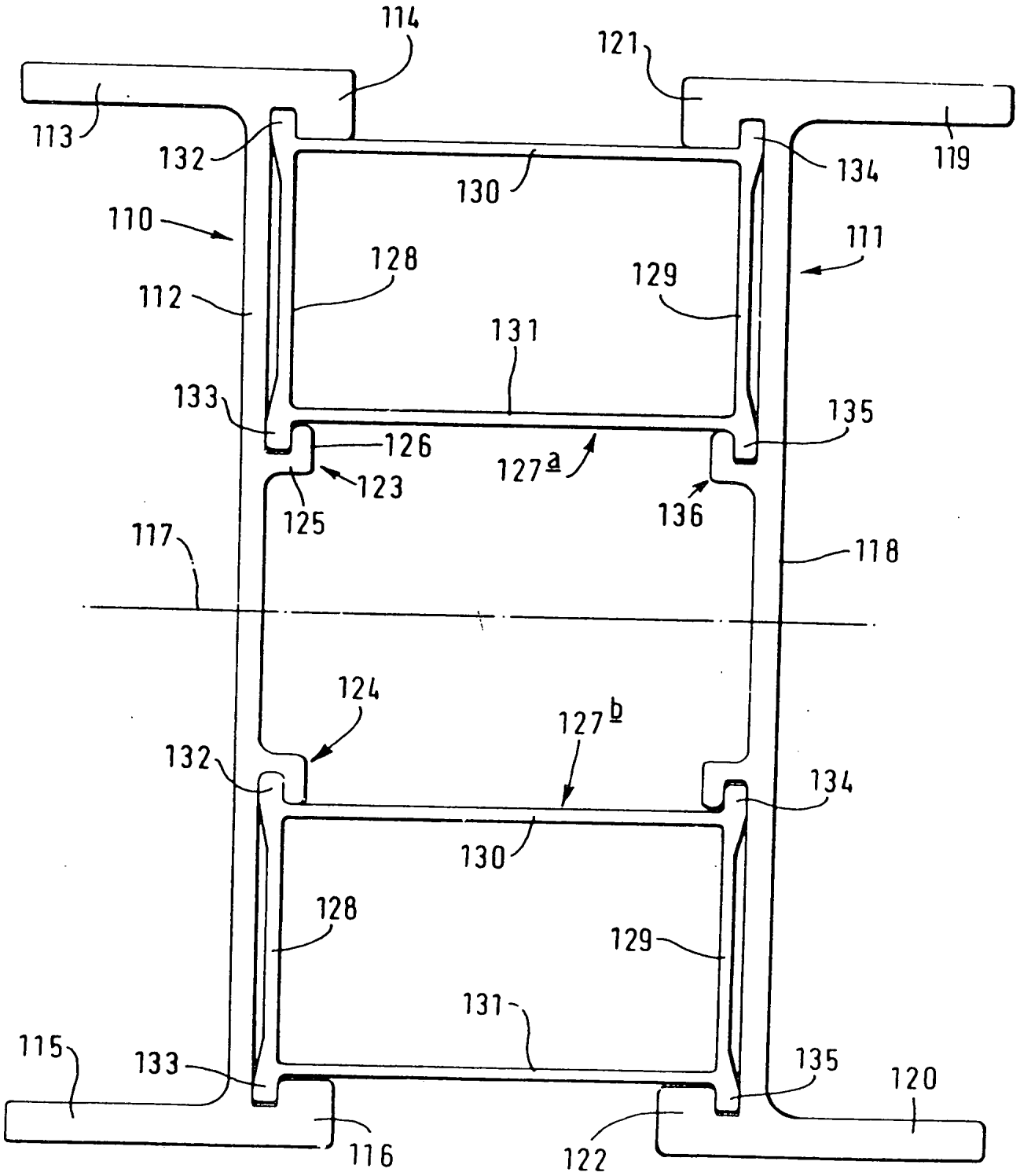
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FIG 2

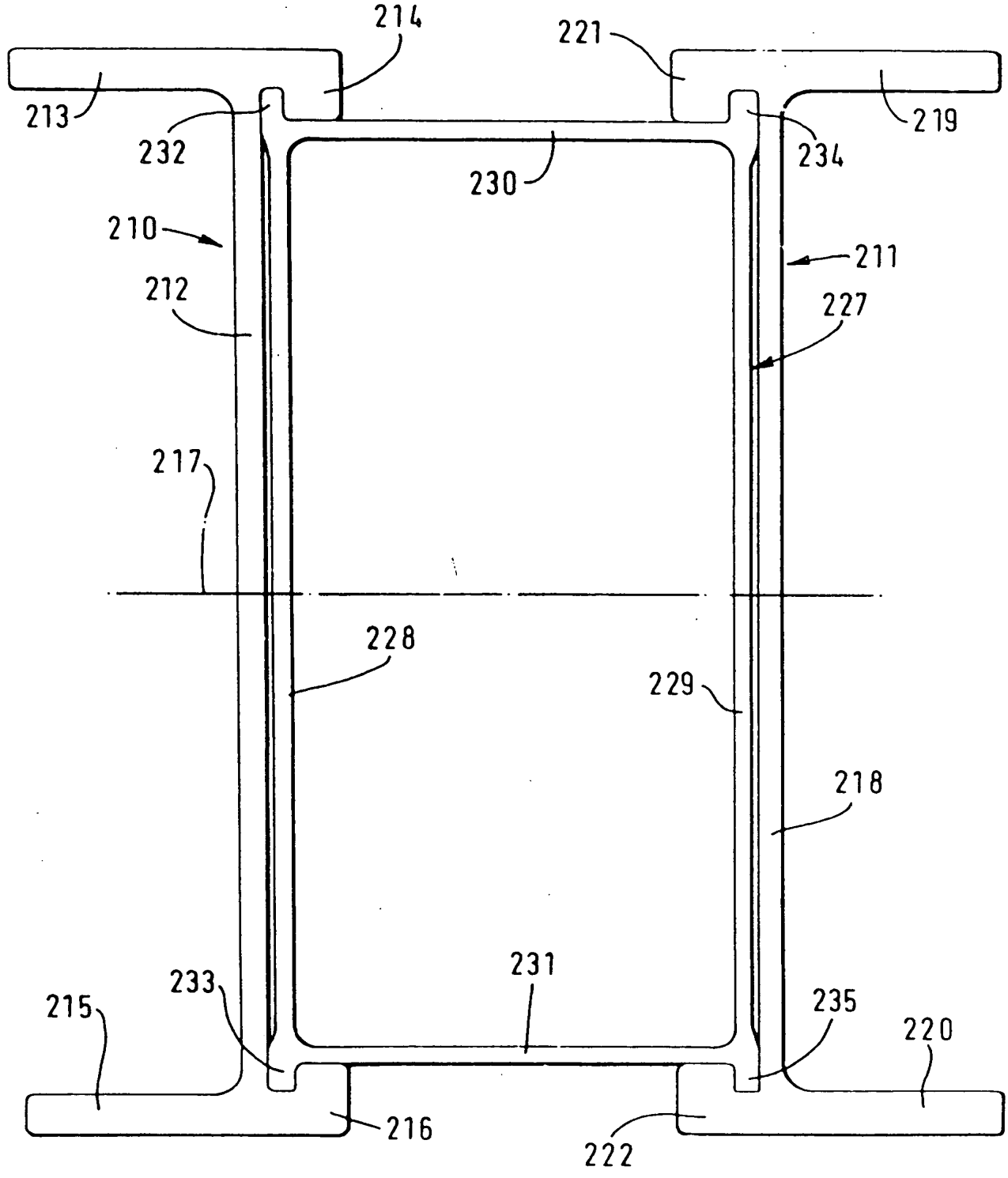
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FIG 3

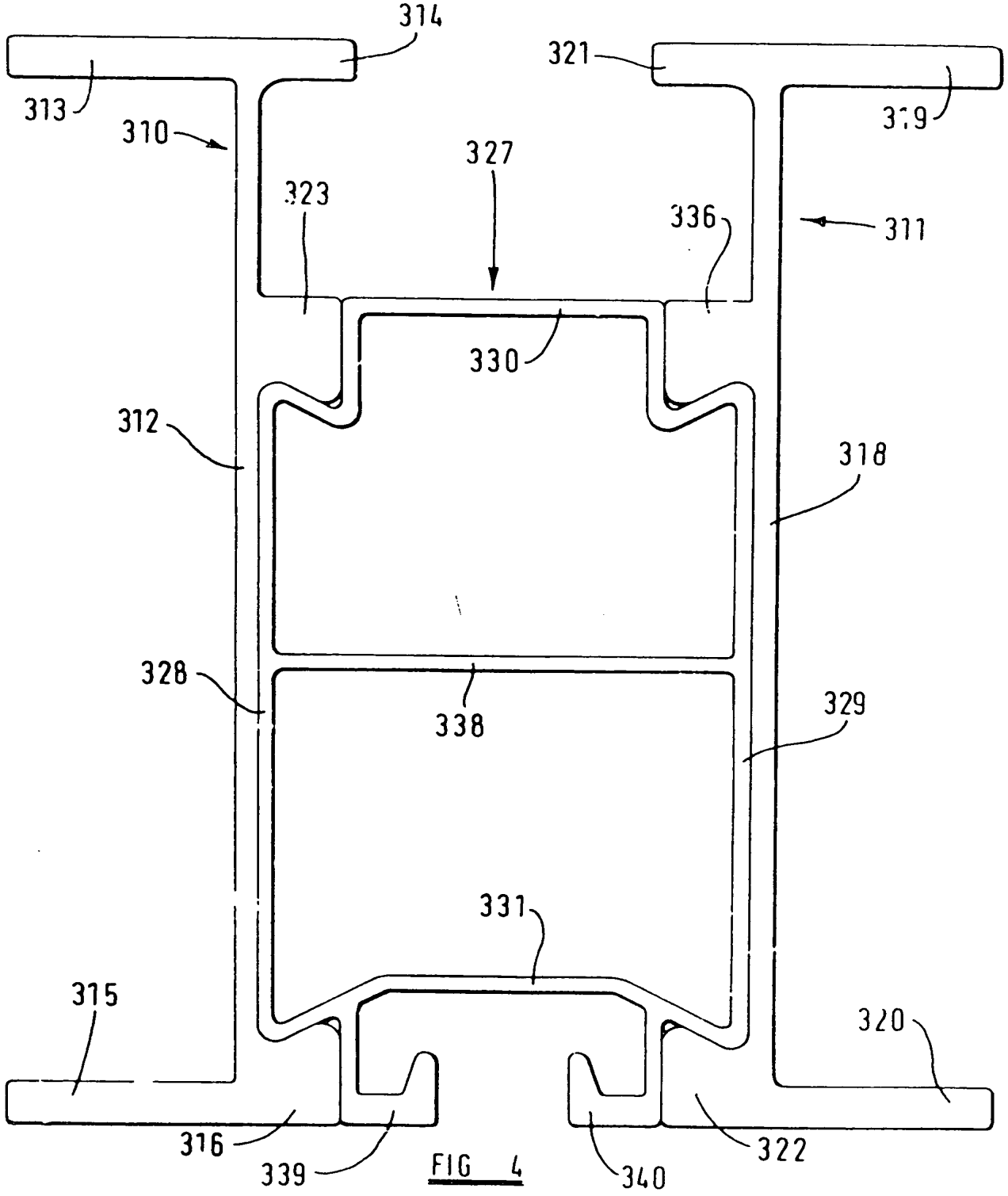
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FIG 4

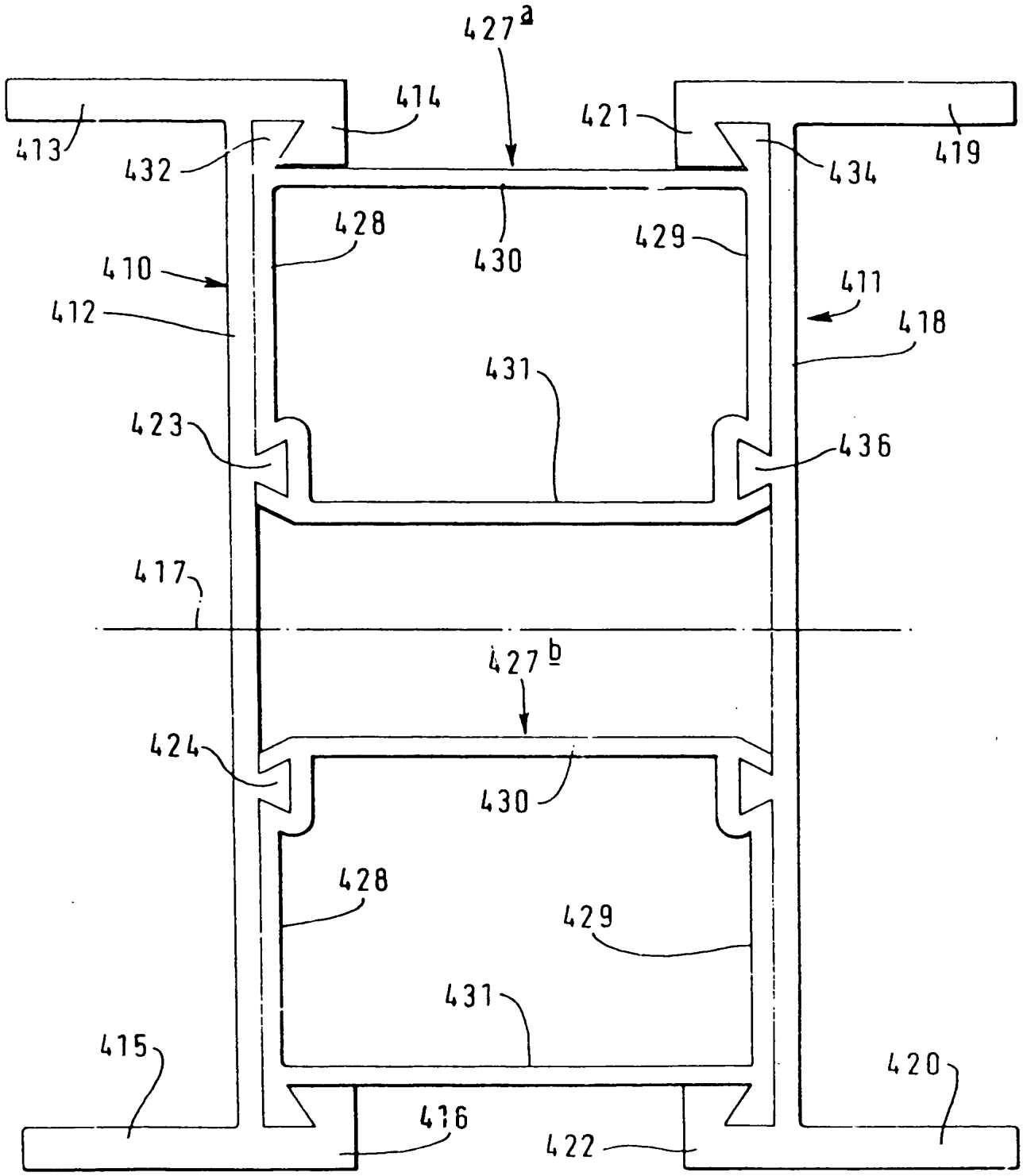
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FIG 5